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REPORT

District of Ucluelet

Feasibility Study of Water Treatment Upgrades for Mercantile Creek and Lost Shoe Creek Wellfield

FEBRUARY 2020

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1 INTRODUCTION

1.1 Background

The District of Ucluelet (District) water system currently draws water from two sources: Lost Shoe Creek Aquifer (LSCA) groundwater source and Mercantile Creek surface water source. The LSCA is the primary source for the District of Ucluelet, while Mercantile is used as a supplemental source for high seasonal demands and industrial (fish processing) demands during summer months. Treated water is stored at the Matterson Reservoir to meet peak demands when the Mercantile Creek source is not running.

The LSCA Wellfield has four active wells that supply water to the District: Wells #1, #2, #3, and #4. Well #2 is on standby particularly during summer months; therefore, Mercantile Creek is required as a supplemental source during summer months. The groundwater from the Wellfield is treated by the addition of sodium hypochlorite for disinfection (chlorination). However, elevated levels of manganese above the maximum allowable concentration (Health Canada, 2019) are a concern. The District is seeking solutions to enhance treatment at the LSCA Wellfield to meet regulatory requirements.

The Mercantile Creek source passes through a coarse screen to remove large debris at the intake and water is treated using ultraviolet (UV) disinfection and sodium hypochlorite disinfection at the Bay Street Water Treatment Plant (WTP) and pump station building. The Mercantile Creek source has elevated turbidity levels during periods of heavy rainfall and the Operating Permit (Island Health) for this source is conditional, dependent on turbidity levels. The District would like to add treatment of this source to remove turbidity, making this source available year-round.

The District retained Associated Engineering (AE) to conduct a feasibility analysis and develop conceptual designs for treatment upgrades for both the LSCA and Mercantile Creek sources. The objectives of this Feasibility Study, as summarized in this report, include the following:

- Review Mercantile Creek and LSCA water quality data.
- Identify candidate treatment processes.
- Comment on societal impacts.
- Develop conceptual (Class D) cost estimates for capital expenditures.
- Establish annual operating costs and life-cycle expenditures.
- Evaluate environmental considerations and climate change impacts of the proposed concept.

1.2 Project Rationale and Approach

The current groundwater source and supplemental surface water source (used during summer months) for the District's potable water do not meet current regulatory requirements with the existing treatment processes. The District has assigned priority to upgrading the LSCA Wellfield and Mercantile Creek treatment facilities to bring the two treated sources into compliance with Health Canada's *Guidelines for Canadian Drinking Water Quality* (GCDWQ), which govern Island Health (IH) requirements for potable water. Water treatment upgrades for Mercantile Creek and LSCA Wellfield are scheduled to be constructed in years 2021-2022 and 2023-2024, respectively. Additionally, a new water storage reservoir is planned for 2025 with completion in 2026.

The District has developed a long-term plan to address compliance issues of existing water sources, to increase capacity of water supply storage infrastructure, and to increase capacity to meet increasing water demands resulting from population growth within the District. The proposed works and respective timeline were presented to Council in

January 2020 as part of the District's 5-Year Capital Plan. The proposed timeline for water supply infrastructure is presented in Table 1-1.

Table 1-1
District of Ucluelet Proposed Water Supply Infrastructure Upgrades

Year	Proposed Works
2021-2022	Upgrade treatment system at Bay Street WTP for Mercantile Creek
2023-2024	Upgrade treatment system at existing LSCA Wellfield chlorination plant
2023	Develop new access road for LSCA Wellfield treatment plant
2025	Construct new reservoir (3rd in area) located at Highway Reservoir
2026	Establish new well in LSCA Wellfield (Well #5)
2039	Develop new water treatment plant for Kennedy Lake as a new water source

The current water supply capacity is not adequate to meet growing demands of the District. In 2018, AE conducted a treatability study and conceptual design based on using Kennedy Lake as a new water source (Associated Engineering, 2018). The District of Ucluelet still intends to pursue the Kennedy Lake concept as a long-term approach to regional water supply; however, intermediate actions are required to address increasing water demands, improve delivered water quality and increase system resiliency to the local impacts from climate change.

The District's Municipal Infrastructure Review (Koers & Associates Engineering Ltd., 2007) identified Kennedy Lake as the only source of water that can meet the long-term needs of the District of Ucluelet and the West Coast region, which includes the District of Tofino, the Regional District of Alberni-Clayoquot, the Pacific Rim National Park, and several First Nations communities. The District's Water Master Plan (Koers & Associates Engineering Ltd., 2017) reiterated this finding and recommended proceeding with the development of Kennedy Lake to ensure a reliable long-term water supply. The development of Kennedy Lake WTP would be a regional water supply approach, requiring support from all involved parties.

The design flow of 15 ML/d (25-year horizon) for the Kennedy Lake WTP was selected to ensure the combined long term needs of the following neighbouring communities can be met:

- District of Ucluelet
- Yuulu-it-ath First Nation (Ittatsoo 1)
- Alberni-Clayoquot Regional District Area C (including the Tofino/Long Beach Airport and Long Beach Golf Course & Camp Ground)
- Tla-o-qui-aht First Nation (Esowista 3)
- Parks Canada sites (includes the Incinerator Rock day-use area, Long Beach day-use area, administration office site, Green Point Campground, Kwisitis Visitor Centre and Wickaninnish day-use area)
- District of Tofino

The implementation of a new WTP for Kennedy Lake is a long-term plan requiring the support and financial commitment of all involved parties. It is also expected to require supplementary external funding, which has not yet been secured. A phased approach is anticipated for implementation of a new lake intake, water treatment plant, conveyance systems, and distribution infrastructure related to a Kennedy Lake source. In the meantime, the District is seeking solutions to immediate and near-term water treatment and supply issues, with upgrades to the LSCA Wellfield and Mercantile Creek sources, as well as increased storage, being critical to that goal.

2 EXISTING WATER SUPPLY INFRASTRUCTURE

2.1 Lost Shoe Creek Aquifer

The LSCA is the primary water source for the District of Ucluelet. The four wells were developed in 1997 and chemical redevelopment of the wells (to address biofouling) was completed in 2002. The LSCA Wellfield and its existing chlorination facility is located southwest of the junction of Pacific Rim Highway (Hwy 4) and Tofino-Ucluelet Highway, which runs south from the junction in the Alberni-Clayoquot Region. The 2018 Kennedy Lake WTP Feasibility Study indicated plans to locate proposed treatment infrastructure in this area. The District may need to procure additional land for treatment upgrades of LSCA Wellfield.

As shown in Figure 2-1, the LSCA Wellfield water is currently disinfected using sodium hypochlorite (chlorination). The chlorination provides oxidation of metals such as iron and manganese in the water in addition to providing disinfection of the source. The treated water is then delivered to the Highway Reservoir for storage and distribution to users within the District.

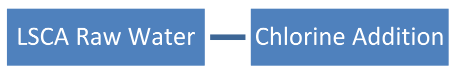

Figure 2-1
LSCA Wellfield Current Process Flow

2.1.1 Water Quality

The range of well water quality for the four active wells in the LSCA Wellfield is reported in Table 2-1 and compared against the *Guidelines for Canadian Drinking Water Quality* (Health Canada, 2019).

Table 2-1
Lost Shoe Creek Aquifer Raw Water Quality (All Active Wells)

Parameter	GCDWQ (Health Canada, 2019)[1]	LSCA Wellfield Raw Water[2]
Turbidity (NTU)	MAC: 0.3	0.21 – 1.24
Total Dissolved Solids (mg/L)	AO: ≤500	34 – 64
Total Aluminum (mg/L)	OG: <0.1	0.005 – 0.115
Total Iron (mg/L)	AO: ≤0.3	0.029 – 0.538
Total Manganese (mg/L)	MAC: <0.12, AO: ≤0.02	0.039 – 1.380
E. Coli (MPN/100 mL)	MAC: 0	0
Total Coliforms (MPN/100 mL)	MAC: 0	1 occurrence of 1/100 mL

1. GCDWQ Acronyms: Maximum Allowable Concentration (MAC), Aesthetic Objective (AO), and Operational Guideline (OG).
2. Results from samples between 1995-2014 and sample from 2018.

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The primary concern is the high concentration of manganese. In 2019, Health Canada stipulated a maximum allowable concentration (MAC) of 0.12 mg/L and a revised aesthetic objective (AO) of 0.02 mg/L for manganese. The water quality data shows that mixing of water from the four wells and the addition of chlorine at the well pump results in manganese levels in the distribution system that are lower than the raw water levels. (The chlorine likely oxidizes some of the manganese and may cause it to settle out at an upstream point in the system.)

Measured levels of total iron have been occasionally above the aesthetic objective (AO) of 0.3 mg/L (Health Canada, 2019) and user complaints have been received concerning the colour and odour of tap water.

It is not apparent that the wellfield is groundwater under direct influence (GUDI) of a surface water source; other wells established by Pacific Rim National Park, located close to LSCA are considered GUDI and may be at risk of containing pathogens (GARP). However, it is not known whether the LSCA Wellfield is GARP. At minimum, a hazard and screening assessment is required for GARP determination of the wellfield.

2.2 Mercantile Creek

Mercantile Creek is a supplementary water source for the District of Ucluelet, used only in summer months to meet increased (seasonal) residential and industrial demands. Mercantile Creek is known to have high organics and turbidity, particularly after heavy rainfall events. The Bay Street WTP was constructed in 1985 implementing greensand filtration and disinfection with chlorine gas for Mercantile Creek, targeting high turbidity attributed to logging activities near the creek; these treatment processes were later removed. In 2014, UV disinfection and chlorine disinfection utilizing sodium hypochlorite solution were implemented.

As shown in Figure 2-2, Mercantile Creek is currently screened at the intake before being pumped to the Bay Street WTP for UV and chlorine disinfection. The treated water is then pumped to the Highway Reservoir, which supplies water to the Matterson Reservoir for distribution to users within the District. The District's Operating Permit (from Island Health) for Mercantile Creek as a water source is conditional on turbidity levels meeting the *Guidelines for Canadian Drinking Water Quality* (Health Canada, 2019). The source is non-compliant during periods of elevated turbidity, typically after rainfall events, and therefore cannot be used during these periods.

Figure 2-2
Mercantile Creek Current Process Flow

2.2.1 Water Quality

The range of water quality data for Mercantile Creek is reported in Table 2-2 against the *Guidelines for Canadian Drinking Water Quality* (Health Canada, 2019).

Table 2-2
Mercantile Creek Raw Water Quality

Parameter	GCDWQ (Health Canada, 2019)	Mercantile Creek Raw Water[1]
Total Alkalinity (mg/L as $CaCO_3$)	N/A	9.7
pH	OG:	6.96
Total Dissolved Solids (mg/L)	AO: ≤500	36
True Colour (TCU)	AO: ≤ 15	21.9 (5-30)
Turbidity (NTU)	MAC: ≤0.3; ≤0.1 if treated with membranes.	0.48 (0.2 – 1.9)
E. Coli (MPN/100 mL)	MAC: 0	25 (1 – 400)
Total Coliforms (MPN/100 mL)	MAC: 0	>200

1. 2018 sample from upstream of Bay St WTP. Values in brackets indicates grab samples collected during each season in 2010 from Mercantile Creek.

The primary concern for the Mercantile Creek source is high turbidity and colour. Table 2-2 illustrates that Mercantile Creek has a high concentration of organics, which are likely contributing to the colour and may present a potential to form disinfection by-products. The low alkalinity and pH indicates that the Mercantile creek is undersaturated and may have tendency to be corrosive in the distribution system. The Langelier Index or saturation index of the source, as well as the formation potential of disinfection by-products should be investigated in further design stages.

2.3 Water Supply Infrastructure

2.3.1 Distribution System

The distribution system contains 35 kms of pipe ranging in diameter from 100 mm to 450 mm of various material types. The distribution network is described in greater detail in the District of Ucluelet Water Master Plan (Koers, 2017).

2.3.2 Reservoir Storage

Highway Reservoir No. 1

The LSCA wellfield pumps chlorinated water into the Highway Reservoir. The Bay Street WTP also pumps treated water to the Highway Reservoir. The Highway Reservoir is a bolted steel tank with a capacity of 1400 m^3,located 3 km south of LSCA wellfield on Peninsula Road. The top water level is 64.8 m with a static pressure of 635 kPa.

Matterson Drive Reservoir

Treated water from the Highway Reservoir is delivered to the Matterson Drive Reservoir using an altitude valve, installed in 2018 to improve water conservation. The Matterson Reservoir is a bolted steel tank with a capacity of 1200 m^3, located in town. The Matterson Reservoir delivers treated water to the distribution system in Ucluelet. The top water level is 57 m with a static pressure of 560 kPa.

Proposed Highway Reservoir No. 2

The proposed Highway Reservoir will be installed beside the existing Highway Reservoir No. 1. The reservoir will be equal in size to Highway Reservoir No. 1 (1400 m^3) and will also constructed from bolted steel. The purpose of this reservoir is to provide additional treated water storage at the Highway Reservoir site.

3 DESIGN CRITERIA

3.1 Water Treatment Objectives

AE has confirmed the guidelines and standards to inform the treatment process selection. As well, key parameters that the District deems important from an operational perspective and to meet consumer expectations with respect to water aesthetics were confirmed. Future design stages will confirm that the WTP is able to meet potential future regulations with increased water quality stringency and confirm the treatability of the two water sources: LSCA Wellfield and Mercantile Creek.

Island Health requirements are governed by the Drinking Water Protection Act (DWPA), the Ministry of Health *Guidelines for Canadian Drinking Water Quality* (Health Canada, 2019). Current non-compliances of treated water from LSCA Wellfield and Mercantile Creek sources are described in sections 2.1.1 and 2.1.2, respectively.

3.1.1 Surface Water Source

Effluent Quality Guidelines and Standards

The District of Ucluelet will operate the Bay Street WTP in accordance with Island Health's stance that water from a surface water source requires filtration and disinfection. According to microbiological treatment objectives, a surface water system must meet the 4-3-2-1-0 drinking water objective, as outlined below:

4: 4-log inactivation of viruses

3: 3-log removal or inactivation of *Giardia lamblia* and *Cryptosporidium parvum*

2: Two treatment barriers [at minimum] for all surface drinking water systems

1: Turbidity less than 1 NTU

0: 0 total and fecal coliforms and *E. Coli*

The concept design for treatment upgrades at the Bay Street WTP (Mercantile Creek source) was developed to meet the 4-3-2-1-0 drinking water objectives. In addition, the DWPA requires that treated surface water supplied through piped distribution systems be subjected to secondary disinfection (chlorination) typically to achieve minimum of 0.5 mg/L free chlorine residual leaving the WTP and a minimum of 0.2 mg/L free chlorine residual at all points in the distribution system.

The finished water shall not exceed the latest revision of the *Guidelines for Canadian Drinking Water Quality* (GCDWQ) published by Health Canada (last updated June 2019). This includes maximum acceptable concentrations (MAC) for any chemical or physical parameters, including disinfection by-products (DBPs). The finished water shall meet the GCDWQ aesthetic objectives (AO), which include ranges for temperature and colour, as well as operational guidelines (OG), such as that for pH.

Seasonal Impacts

The District's *Water Master Plan* (Koers, 2017) indicates that seasonal impacts influence water supply in the District of Ucluelet: Well # 2 of LSCA is unable to supply water due to low aquifer levels during summer dry periods, and Mercantile Creek typically has elevated turbidity after rainfall events. The proposed treatment upgrades are designed to handle this observed variability in water quality as well as the anticipated impacts of climate change on water

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quality and quantity and use conservative design criteria. Seasonal impacts and emerging trends in water quality should be investigated further during preliminary design.

Corrosivity and Disinfection By-Products

The surface water from Mercantile Creek has high organics and low alkalinity. The low alkalinity increases the likelihood of delivered water being corrosive in distribution lines. The addition of soda ash to raw water prior to chemical pre-treatment increases pH and alkalinity and can be used to mitigate corrosivity. Stabilization of alkalinity is a key factor for controlling water corrosivity and pipe scaling within the distribution system. Mercantile Creek raw water has an alkalinity that is considered low (<10 mg/L as $CaCO_3$) with a tendency of being corrosive. Treatment should include alkalinity addition and pH adjustment using a base.

The presence of organics in the water may present a potential to form disinfection by-products (DBP) at unacceptable levels. Strategies to mitigate the formation of disinfection by-products include removal of DBP precursors at the source and impacting parameters that affect DBP formation, such as: organics, alkalinity, colour, pH, UVT.

3.1.2 Groundwater Source

Groundwater at Risk of Containing Pathogens

The likelihood of being considered groundwater at risk of containing pathogens (GARP) is low due to the distance of the wellfield from any surface water source that could influence groundwater conditions. However, a well vulnerability assessment should be conducted in future design stages to confirm assessment steps outlined in the Ministry of Health's *Guidance Document for Determining GARP including GUDI* (Ministry of Health, 2012). The possible stages of assessment in the guidance document are:

- Stage 1: Hazard Screening and Assessment
- Stage 2: GARP Determination – The drinking water officer (DWO) reviews the hazards identified in Stage 1 to determine if the groundwater source is "at risk" of containing pathogens (GARP), "GARP-viruses only", or "at low risk" of containing pathogens (Non-GARP)
- Stage 3: Risk Mitigation – Mitigation measures or groundwater considered to be GARP, such as further investigating specific hazards, taking corrective measures, or through treatment acceptable to the DWO
- Stage 4: Long-term Monitoring of source water quality and hazards

AE recommends that a Stage 1 hazard screening and Stage 2 GARP determination be conducted for LSCA Wellfield. For this concept, as a conservative approach, AE assumes that Wells 1, 2, 3 and 4 of LSCA are considered to be GARP; proposed treatment is described in Section 4.1.

High Concentration of Metals (Iron and Manganese)

An oxidation-filtration process is a proven technology for removal of iron and manganese and is assumed here to be suitable treatment for the LSCA Wellfield groundwater. The proposed concept is discussed in Section 4.1.

3.2 Capacity and Flows

3.2.1 Water Demands

The average daily demand is estimated to be 30 L/s, averaged over the highest annual flow from 2011 to 2015 reported in the District's latest *Water Master Plan* (Koers, 2017). The maximum daily demand is estimated to be 75 L/s. Increased tourism activity and population growth are expected to cause an increased water demand for the District.

In the 2018 Kennedy Lake Treatability Study, AE estimated conservative future water demands for Ucluelet and Ittatsoo FN to have an average daily demand of 63 L/s and maximum daily demand of 127 L/s for a 25-year horizon (Associated Engineering, 2018).

3.2.2 Lost Shoe Creek Aquifer Wellfield Capacity

When originally developed in the mid-to-late 1990s, the LSCA Wellfield was able to produce 122 L/s (10,500 m^3/day). As of 2020, the capacity of the four wells has declined to 94 L/s (8,100 m^3/day) (Koers, 2017).

3.2.3 Mercantile Creek Capacity

The District of Ucluelet Licence for Mercantile Creek is for 45 L/s (3,864 m^3/day). However, the District also supplies water to Ucluelet First Nation (UFN) who have a licence for 5 L/s (454 m^3/day), so the combined withdrawal permitted is 50 L/s (4,318 m^3/day) for Mercantile Creek. The current raw water pumps are run on a variable frequency drive (VFD) that allows flow rate to turn down effectively to 28 L/s.

3.2.4 Hydraulic Profile

The well pumps for the LSCA Wellfield currently deliver water to the Highway Reservoir. The addition of treatment equipment at the LSCA Wellfield would introduce marginal pressure losses to the system. AE assumes that no additional booster pump will be required to deliver treated water to the reservoir.

The current treatment system at the Bay Street WTP provides adequate pressure to deliver the maximum treated water flow to the Highway Reservoir. AE assumes that no additional booster pump will be required to deliver treated water to the reservoir. The addition of treatment equipment at Bay Street WTP includes interim feed pumps for process water for continued delivery to the existing disinfection system.

The hydraulic profile of each treatment system should be investigated in detail during future design stages.

3.3 Environmental and Societal Impacts

3.3.1 Climate Change Mitigation and Adaptation

Further development during preliminary and detailed design stages will incorporate the Envision framework (developed by the Institute for Sustainable Infrastructure) for guidance on sustainable best practices. Post-disaster infrastructure design criteria (typically applied to water treatment supply infrastructure) will also be used to mitigate plant shutdown following a disaster event, such as an earthquake.

AE recommends remote monitoring and elevated electrical equipment for the proposed treatment upgrades should access to treatment facilities be compromised during extreme weather events. The proposed treatment includes provisions for short-term events, such as high turbidity due to precipitation, as well as provisions for long-term climate change impacts, such as increased algae due to higher average temperatures and increased organics due to wildfires.

Lost Shoe Creek Aquifer Wellfield

The LSCA is a highly productive sand and gravel unconfined aquifer of 15 m thickness at a depth of 3 to 18 m. There is an active Ministry of Environment observation well located within the aquifer area. The water level drop occurs in summer months and is likely driven by low precipitation, and then the water levels rise that occurs each fall is likely driven by recharge from winter precipitation. The aquifer recharges fully each winter, eliminating any concern for multi-year droughts.

Although climate change does impact the recharge to unconfined aquifers, this aquifer is thick relative to potential water level fluctuations, and gets recharged again each winter, the aquifer should be suitable for long-term supply. AE recommends a 48-hour pumping test, a quantitative assessment of recharge sources, and long-term monitoring as part of a more detailed evaluation to confirm the level of robustness of the aquifer.

Mercantile Creek

The Mercantile Creek minimum daily flow is 106 L/s and maximum daily flow is 20,300 L/s. The minimum day flow is equal to 2.1 times the licensed maximum day withdrawal limit. Thus, having a minimal impact on the water source. A coarse screen is used at the intake in Mercantile Creek to prevent large debris from entering the Bay Street WTP, but also to protect natural resources from being withdrawn from the creek.

Mercantile Creek is susceptible to weather events, such as periods of heavy rainfall and drought. Such events are anticipated to increase in severity and frequency as a result of climate change impacts. In both cases, the impact can be degraded water quality and quantity.

3.3.2 Societal Impacts

The District of Ucluelet's current water supply sources require additional treatment to meet potable water standards (i.e. *Guidelines for Canadian Drinking Water Quality*, Health Canada, 2019). The LSCA Wellfield and supplemental Mercantile Creek sources supply water to the District as well as the Ucluelet First Nation. Future, long-term plans for development of a new WTP for utilizing Kennedy Lake as a source will serve the larger region. All affected parties are described in Section 1.2.

3.3.3 Energy Efficiency Standards

The new WTP will include both administrative areas (human-occupied spaces), such as the control room, and equipment areas, which are generally considered to be unoccupied spaces, designated for process and electrical equipment.

Administrative areas will be heated to 20°C (typical room temperature for human occupancy) and will be designed to satisfy the energy requirements under the National Energy Code for Buildings (NECB). This may be achieved through sufficient building envelope insulation, airtightness and ventilation energy recovery to minimize heat loss.

Equipment areas will be maintained at ambient conditions during the summer and will be heated to 5°C in the winter to avoid near-freezing conditions and ensure equipment operation.

Further development during preliminary and detailed design stages will target the BC Energy Step Code for Administrative areas. The Step Code is a voluntary provincial standard for new buildings aiming for performance above code-minimum; it requires airtightness testing during construction. Energy efficiency opportunities in both the administrative and equipment areas may be explored using energy modelling tools and Step Code measures for guidance.

4 WATER TREATMENT CONCEPT DEVELOPMENT

The proposed approach for treatment of the two water sources are described in the following subsections.

4.1 Lost Shoe Creek Aquifer Wellfield

AE proposes the addition of filtration-adsorption media filters, followed by UV disinfection and chlorination for treatment of the LSCA Wellfield. Based on the review of available raw water quality, AE proposes the following treatment upgrades for Mercantile Creek:

- Chlorine addition for oxidation of iron and manganese.
- Filtration-adsorption for iron and manganese removal.
- Provision for UV disinfection for *Crypto* and *Giardia* inactivation if wells are classified as GARP.
- Chlorine disinfection for virus inactivation.

The process flow of the proposed treatment upgrades is shown in Figure 4-1. AE assumes a design flow of 94 L/s for LSCA Wellfield treatment for a 20-year horizon.

4.1.1 Treatment Upgrades Siting

The LSCA Wellfield site contains existing pumping and chlorination infrastructure housed in a well pumphouse. The proposed treatment upgrades will be located at the existing LSCA Wellfield site. The proposed WTP is estimated to be a single storey building of 25 m x 15 m with an internal height of 4.5 m with a below-ground residuals (waste) tank located between the WTP and the access road. A new access road will be required from the highway to the new WTP. The site plan for the proposed works is shown on Figure 4-2.

AE assumes that existing pump house will not be used for proposed upgrades, but the existing comment header of the four wells will be used to divert flow into the new WTP. There is opportunity to reduce the building footprint in future design phases through optimization of the following components:

- UV disinfection may not be required if wells are classified as non-GARP.
- Oxidant tank may not be required if oxidation can be achieved in process piping during piloting.
- Backwash residuals may be reduced by recycling supernatant at the head of the WTP, reducing the size of the waste holding tank.

4.1.2 Oxidant Pre-Treatment

This conceptual design is based on the addition of 12% sodium hypochlorite solution (SHS) for pre-treatment, upstream of a gravity media filtration system. Chemical metering pumps will deliver SHS to the raw water line. Mixing will be achieved with a static in-line mixer. The addition of chlorine upstream of media filters will serve to oxidize the iron and manganese and act as a disinfectant.

Space provisions are made for a pressurized oxidant contact tank with baffling (to minimize short-circuiting of flow) in the WTP. However, AE assumes that a tank is not be required and that sufficient oxidant contact time can be achieved through the process piping between chlorine injection and the pressurized media filters.

SHS will be delivered to site in 1230 L totes, with space provisions to store two totes in the chemical room at a time: one sealed and one in use. A chemical spill pallet, located under the chemical totes, will be sized to hold 110% of the volume of one SHS tote.

4.1.3 Media Filtration

For conceptual design purposes, the filtration system has been conservatively sized; this could be refined through a pilot-scale treatment study prior to further design stages. The proposed media filtration system will consist of four pressurized carbon steel filters operating in parallel. Each filter is 1.8 m in diameter and 1.5 m in height. The filters will be constructed from epoxy-coated carbon steel. Complete with an internal stainless steel underdrain system, each vessel will contain a 455 mm bed depth of anthracite and a 610 mm bed depth of a greensand media. The filters will have a filtration rate of 15 m/h with three vessels in operation and one filter as standby, and 12 m/h with all four vessels in operation.

Filter Backwash

Filter backwashing consists of reversing flow through the pressure filters using treated water to remove accumulated iron, manganese, and other constituents caught in the media bed. It is anticipated that regular backwashing of the filters will be required every five days. Filter backwash water for a single filter will be supplied from the other filters in service. Each backwash is expected to last ten minutes, during which backwash waste is sent to the waste equalization tank.

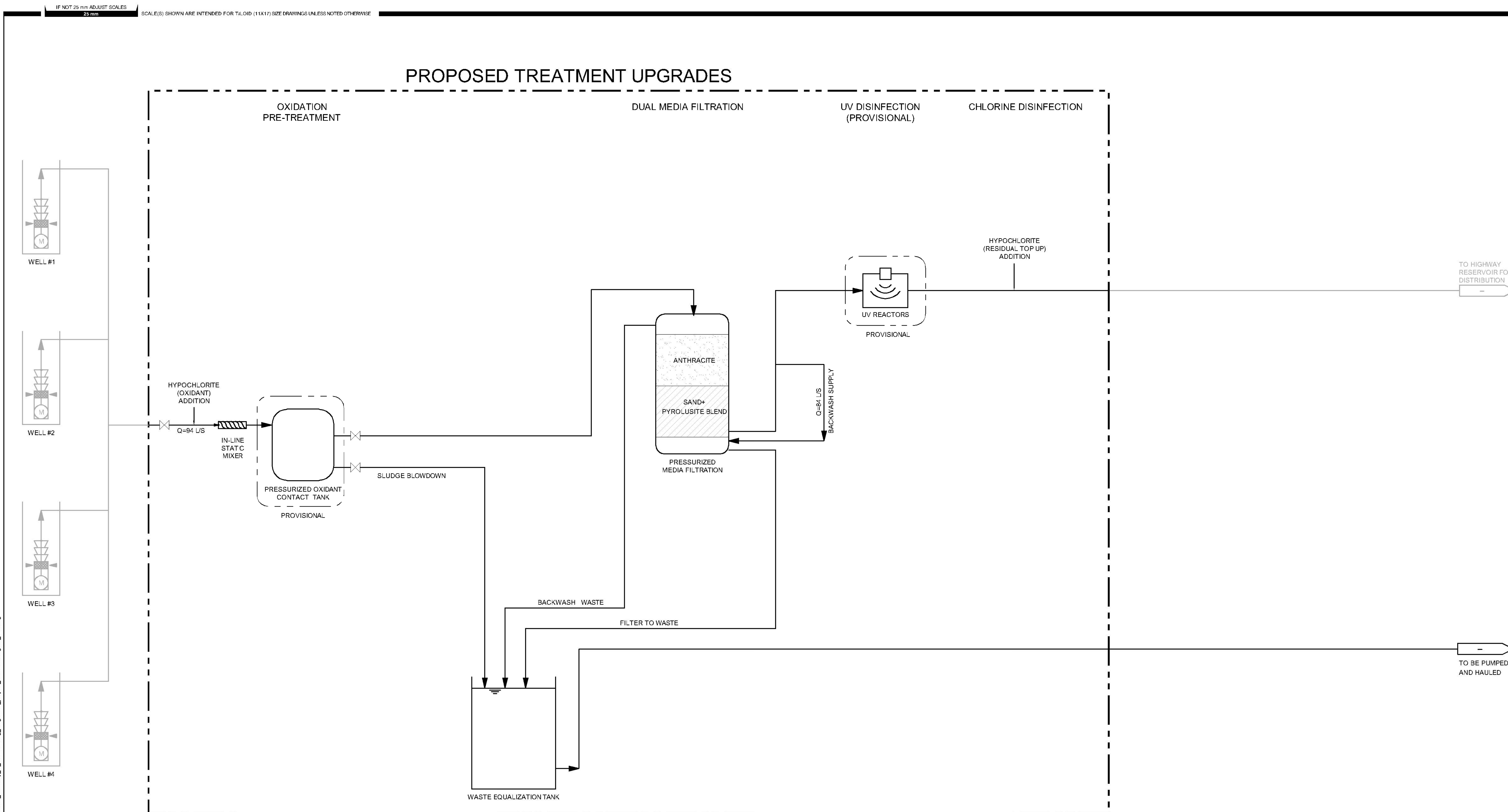
Directly after backwashing, a ripening period of ten minutes is expected, which allows filter effluent to reach optimum quality at the start of a filter run. During the ripening period, filter effluent is sent to the waste equalization tank.

4.1.4 UV Disinfection (Provisional Item)

The LSCA Wellfield is currently treated under the assumption that wells are not considered to be GARP. AE assumes that the wells are GARP, until an assessment is carried out during future design stages. With this assumption, AE proposes provisional treatment for GARP, which requires treatment (3-log removal / inactivation) for protozoa (i.e., *Cryptosporidium parvum* and *Giardia lamblia)*, as well as treatment for viruses (4-log removal / inactivation).

Typically, filtration is used to remove the protozoa. Subsurface filtration in the aquifer can be considered as one of the required treatment processes and LSCA wells may be eligible for Filtration Exemption as per the Drinking Water Objectives (Microbiological) for Groundwater Supplies in BC (Ministry of Health, 2015). Subsurface filtration could satisfy the filtration step required for protozoa removal prior to disinfection. A Filtration Exemption might be contemplated by Island Health if the following criteria are met:

- Overall inactivation is achieved using a minimum of two disinfection strategies, providing 4-log reduction of viruses and 3-log reduction of *Cryptospordium* and *Giardia*.
- Number of *E. coli* in the raw water does not exceed 20/100 mL (or if no E. coli data is available, less than 100/100 mL of total coliform) in at least 90% of the weekly samples from the previous six months.
- Average daily turbidity levels measured at equal intervals (at least every four hours) immediately before the disinfectant is applied are around 1 NTU, but do not exceed 5 NTU for more than 2 days in a 12-month period.



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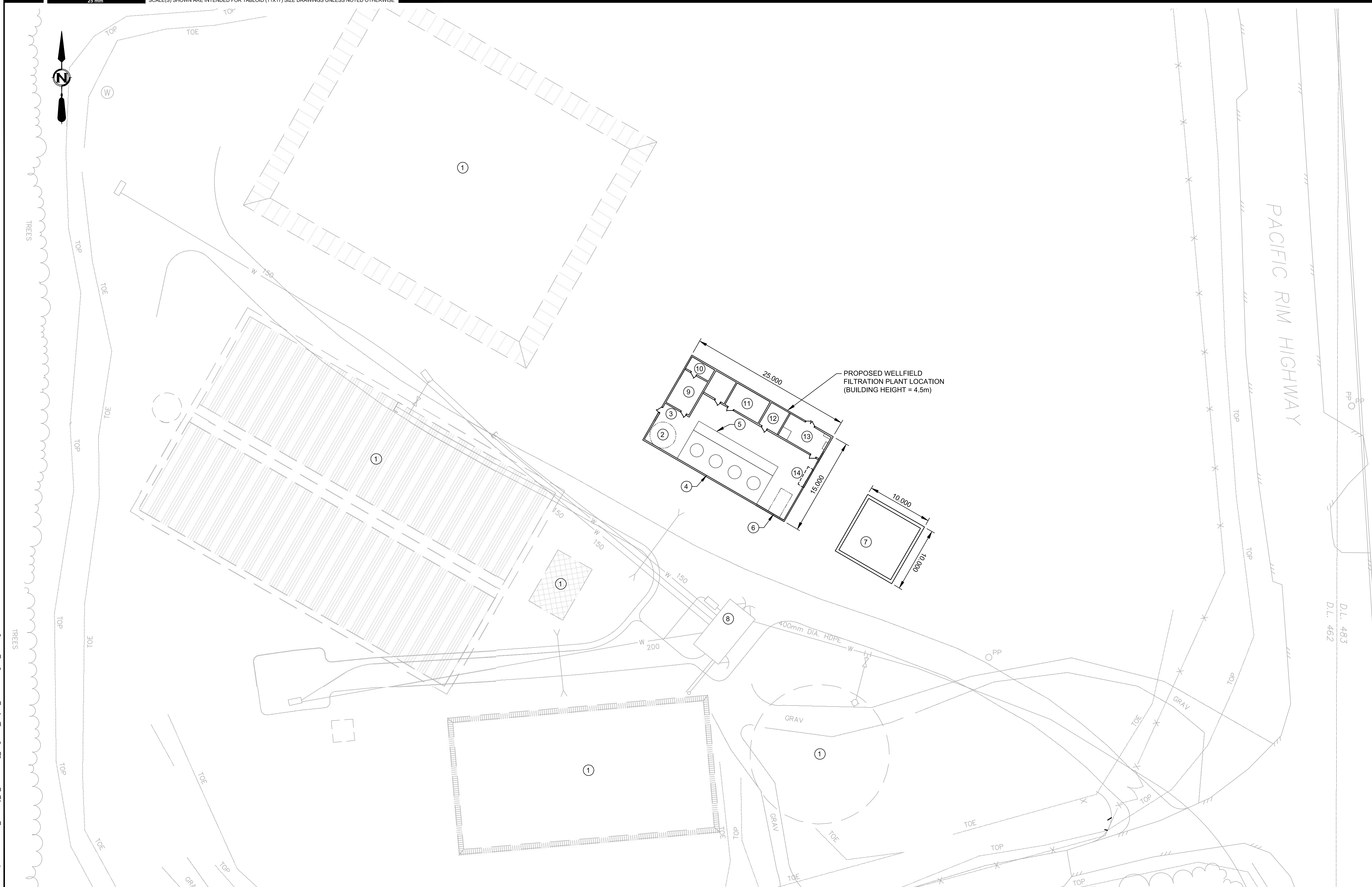
AE PROJECT No.	20172163-00
SCALE	NONE
APPROVED	R.T.
DATE	2020FEB26
REV	A
DESCRIPTION	FEASIBILITY STUDY

FIGURE 4-1

DISTRICT OF UCLUELET LOST SHOE CREEK
WELLFIELD TREATMENT UPDGRADES

PROCESS MECHANICAL
P&ID
PROCESS FLOW DIAGRAM

IF NOT 25 mm ADJUST SCALES
25 mm
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



KEY NOTES:

1. DOTTED GRAY AREA INDICATES PROPOSED FUTURE WORKS FOR KENNEDY LAKE WTP.
2. OXIDANT CONTACT TANK (PROVISIONAL)
3. BACKWASH WASTE TANK BOTTOM LEVEL (SUB-GROUND). DEPTH=4.5m.
4. FILTER SKID
5. CLEARANCE FOR PIPES
6. UV REACTORS (PROVISIONAL)
7. WASTE EQUALIZATION TANK (TO BE PUMPED AND HAULED) V-202m^3. All 4 FILTERS' WASTE (1 WEEK).
8. EXISTING CHLORINATION BUILDING
9. CONTROL ROOM
10. WASHROOM
11. MECHANICAL ROOM
12. ELECTRICAL ROOM
13. CHEMICAL ROOM
14. ROLL-UP DOOR

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DATE	2020FEB26
REV	A
DESCRIPTION	FEASIBILITY STUDY

FIGURE 4-2

DISTRICT OF UCLUELET LOST SHOE CREEK
WELLFIELD TREATMENT UPGRADES

CIVIL

SITE PLAN

Based on the information available on the raw water quality of the LSCA Wellfield groundwater and the assumption that filter effluent turbidity is expected to be <1 NTU following oxidation and greensand filtration for manganese removal, AE has assumed that the Filtration Exemption criteria can be met.

For the two methods of disinfection that would be required, it is recommended that a combination of UV irradiation and chlorination be used. The provisional UV system would be sized to provide 3-log inactivation of *Cryptosporidium* and *Giardia* with one duty and one standby reactor. In the event that Island Health does not approve the application for Filtration Exemption for the LSCA Wellfield, additional treatment through a physical removal barrier may be required, but this is also dependant on the GARP assessment results.

Although space provisions are made, UV disinfection is not included as part of this concept or cost estimate.

4.1.5 Secondary Disinfection

Provisions for chlorine top-up through sodium hypochlorite solution (SHS) addition is included in this concept to ensure a minimum chlorine residual of 0.5 mg/L is achieved prior to distribution to maintain a 0.2 mg/L residual in the distribution system. A second chemical dosing pump skid is planned within the chemical room for injection downstream of filters.

AE assumes that chlorination be used to inactivate viruses (4-log removal). Given the 3 km distance between the LSCA Wellfield and the Highway Reservoir, AE does not recommend the use of a clearwell for virus inactivation. The distance to the reservoir provides sufficient chlorine contact time to achieve 4-log inactivation of viruses, assuming a target CT of 8 mg/L·min.

4.1.6 Residuals Management

All process waste streams will be collected in a waste equalization tank large enough to hold the backwash waste volume and ripening period (discharge to waste) volume of four filters for ten days. A maximum of two filters would be backwashed in one day. Backwash frequency is once every five days. Since there is no existing connection to the sanitary force main, with the nearest connection at a distance of 5 km, AE assumes that waste will be pumped and hauled to the District's wastewater lagoon site every 5-10 days. The in-ground waste holding tank is 15 m x 15 m with a depth of 4.5 m.

There is an opportunity to recycle a portion of the supernatant from the backwash waste to reduce the quantity of backwash residuals to be managed at the LSCA Wellfield site and to maximize treatment efficiency. AE recommends that opportunities to reduce the residuals waste quantities be investigated further during preliminary design.

4.2 Mercantile Creek

AE conducted a treatability study on Kennedy Lake in 2018, a surface water source in Ucluelet with similar raw water quality to Mercantile Creek. AE assumes that the treatment processes and design conditions achieved during the pilot study for Kennedy Lake are applicable to the treatment requirements for Mercantile Creek. AE recommends that a treatability study including bench-scale and pilot-scale testing is conducted as part of the preliminary design phase to confirm the treatability of the Mercantile Creek source.

Based on the review of available raw water quality, AE proposes the following treatment upgrades for Mercantile Creek:

- Soda ash addition to reduce corrosivity of water and improve coagulation conditions.
- Coagulation to assist filtration of organics.
- Fine screens to remove particles protect membrane units.
- Membrane filtration to reduce turbidity and remove microbiological parameters.

The process flow of the proposed treatment upgrades is shown in Figure 4-3. AE assumes a design flow of 50 L/s for Mercantile Creek treatment for a 20-year horizon. The proposed process is consistent with the findings of the pilot-scale study for the Kennedy Lake source conducted in 2018 which had similar raw water quality (Associated Engineering, 2018).

Pilot-scale testing of using Mercantile Creek raw water will assist in determining whether a conventional settling step or dissolved air filtration (DAF) would significantly improve filtration, as opposed to direct filtration. DAF technology has been deemed effective in other surface water applications on Vancouver Island, such as Ladysmith (for the Arbutus WTP Phase 2, now under construction), and Tofino's WTP; however, it was not found to be effective in Nanaimo during the pilot-scale study for the South Fork Water Treatment Plant, which instead employs direct membrane filtration.

If a convention settling step or DAF treatment is required upstream of filtration, the District would either need to acquire more land for treatment processes or reconsider the volume of supply supplemented by the Mercantile Creek. If the supply pump is turned down to 28 L/s (current capabilities), the proposed WTP could accommodate a DAF or settling step. The proposed membrane treatment is planned for parallel train (one duty, one standby) operation. The proposed design could be optimized during detailed design if DAF or settling is required.

4.2.1 Treatment Upgrades Site

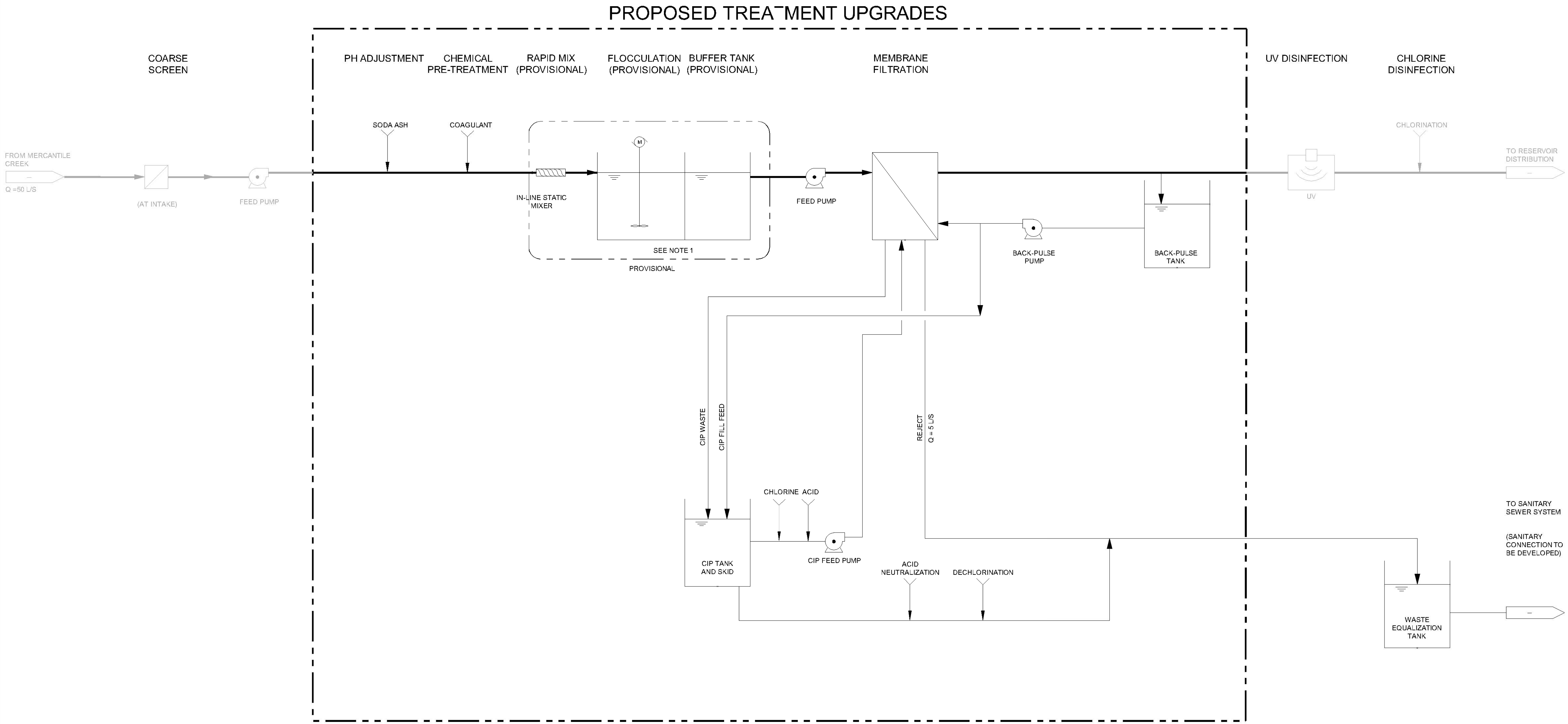
As shown in Figure 4-4, the proposed WTP addition is estimated to be a single storey building with a footprint of 11 m x 9 m for membranes, membrane cleaning chemicals and equipment, and ancillary equipment, as well as a 4 m x 5 m extension for the storage of CIP chemicals and neutralizers.

AE assumes that provisional pre-treatment flocculation tanks could be located outside of the existing Bay Street WTP, while pre-treatment chemical storage and metering pump skid, and electrical equipment will be located within the existing WTP.

The existing fire hydrant located west of the Bay Street WTP must be relocated to accommodate proposed flocculation tanks. The existing electrical pole located on the east side of the Bay Street WTP is also to be relocated to accommodate the new treatment building.

The proposed concept assumes that raw water is diverted from the inlet pipe at the Bay Street WTP to new treatment equipment, and then returns to meet existing process piping leading to the existing UV disinfection and chlorination steps prior to distribution.

IF NOT 25 mm ADJUST SCALES
25 mm
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



NOTES:

1. DISSOLVED AIR FLOTATION MAY BE REQUIRED AFTER FLOCCULATION UPSTREAM OF MEMBRANES SUBJECT TO FURTHER INVESTIGATION DURING PRELIMINARY DESIGN.

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AE PROJECT No.	20172163-00
SCALE	NONE
APPROVED	R.T.
DATE	2020FEB26
REV	A
DESCRIPTION	FEASIBILITY STUDY

FIGURE 4-3

DISTRICT OF UCLUELET
MERCANTILE CREEK TREATMENT UPGRADES

PROCESS MECHANICAL
P&ID
PROCESS FLOW DIAGRAM

IF NOT 25 mm ADJUST SCALES
25 mm
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

KEY NOTES:

1. EXISTING UV SYSTEM
2. EXISTING CHEMICAL ROOM
3. EXISTING HYDRANT TO BE RELOCATED
4. EXISTING ELECTRICAL POLE TO BE RELOCATED
5. INLINE FLASH MIXING. FLOCCULATION TANKS AND BUFFER TANK. PUMPS IN BUFFER TANK. (PROVISIONAL)
6. PUMP SKID (FLOCCULATION TO MEMBRANES) (PROVISIONAL)
7. SODA ASH STORAGE
8. COAG STORAGE AND METERING PUMPS
9. SODA ASH MIXING TANK AND METERING PUMP
10. ELECTRICAL PANELS
11. CIP PUMP SKID
12. CIP TANK ($6M^3$)
13. CIP CHEMICAL STORAGE AND METERING (ACIDS, CHLORINE, NEUTRAILZERS). METERING PUMPS TO BE WALL MOUNTED) CHEMICALS STORED IN TOTES OR DRUMS (MAX. $1M^3$ STORAGE) .
14. COMPRESSORS AND BLOWERS FOR HYDRAULIC CLEANS.
15. WASTE EQUALIZATION TANK = $1.2m^3$, IF 1m HIGH, 1mX1.2m, W/ SUBMERSIBLE PUMPS TO SANITARY.
16. MEMBRANES AND PIPING CLEARANCE
17. RETAINING WALL
18. INLINE STATIC FLASH MIXING (IN BUILDING)
19. ROLL-UP DOOR
20. BACK PULSE STORAGE TANK

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AE PROJECT No.	20172163-00
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DATE	2020FEB26
REV	A
DESCRIPTION	FEASIBILITY STUDY

FIGURE 4-4

DISTRICT OF UCLUELET
MERCANTILE CREEK TREATMENT UPGRADES

CIVIL

SITE PLAN

4.2.2 Strainers

Strainers are used to mitigate performance issues of process equipment due to debris and fines entering the system. The existing coarse screen used at the Mercantile Creek intake is used to protect valves and instruments from clogging within the WTP. Fine screens are included at the head of the membrane treatment system to protect membrane modules from fine materials. Two fine screens (one per train) with 0.5 mm pore size are assumed.

4.2.3 Pre-Treatment – Coagulant and Alkalinity Addition

Chemical pre-treatment consists of coagulation and may also require alkalinity addition prior to membrane filtration. Chemical pre-treatment is not always required for membrane filtration as the absolute pore size of the membranes is the barrier that removes microbiological and particulate contaminants. This concept assumes that pre-treatment with coagulation will be required to enhance the ability to remove organics.

Increased alkalinity typically improves the efficacy of the coagulation step and reduces corrosion potential of treated water in the distribution system. Membranes may also require a minimum alkalinity to guarantee membrane performance. AE assumes that soda ash addition is required for pre-treatment; however, this should be confirmed during further design development via treatability tests.

This concept assumes a dose of 10 mg/L of soda ash and a dose of 20 mg/L of alum for chemical pre-treatment. These doses should be evaluated and refined during future bench and/or pilot-scale treatability studies. The pre-treatment chemicals would be added to the raw water line using chemical metering pumps (one duty, one standby for each chemical).

Soda ash is delivered as bulk powder in bags, which will be stored in the chemical room in the existing Bay Street WTP. An operator would mix bulk soda ash powder with treated water to create a solution for chemical metering. Alum solution is stored in 250 L drums within a chemical room inside the existing Bay Street WTP.

A chemical spill pallet, located under each set of chemical drums, will be sized to hold 110% of the volume of stored chemicals.

4.2.4 Pre-Treatment – Mixing and Flocculation (Provisional Item)

It is typical to add coagulants without mixing upstream of membrane filtration. AE assumes that chemical mixing and flocculation is not required upstream of membranes. Flocculation in the presence of coagulant occurs in a two-stage process consisting of rapid mixing to facilitate coagulation, followed by gentle mixing to facilitate flocc formation. AE has made space provisions for flocculation tanks sized to achieve a typical hydraulic retention time (HRT) of ten minutes.

Two provisional concrete flocculation tanks would be located outside and to the west of the Bay Street WTP. The flocculation tanks would be 4.5 m in height, each equipped with a standing mixer. The flocculation tanks would spill into a buffer tank from which water is pumped to the membrane system. The provisional buffer tank is used as an interface between a constant flow of pre-treated water flowing in and membrane system drawing water downstream at variable rates. The provisional buffer tank would be sized for storage during membrane system downtime, to be determined in future stages of design. The provisional flocculation and buffer tanks would be covered and secured within a fenced area to prevent any public or weather interference.

Although space provisions are made, mechanical mixing, flocculation, and buffer tanks are not included as part of this concept or cost estimate.

4.2.5 Membrane Filtration

Ultrafiltration membranes are made up of hundreds of small hollow fibres in multiple cartridge units, with each fibre having many 0.1 µm pores or smaller that filter the water. The raw water is either pumped or pulled via vacuum through the membrane resulting in clean water (filter permeate) with the larger particles retained in the reject water stream (retentate).

As the membranes filter water, the pores of the membranes can become clogged or fouled by particulate material and organic matter. When sufficient fouling has occurred, the membranes require hydraulic cleaning and chemical cleaning as means to remove fouling materials and assure membrane performance.

The membrane system consists of two trains (one duty, one standby), each capable of treating the net design flow and containing a total of 72 modules. AE assumes a design flux for the membranes of 43 L/m^2/h, which was conservatively selected based on the flux achieved during piloting at Kennedy Lake in 2018 (Associated Engineering, 2018).

Membrane Hydraulic Cleans

A typical membrane system includes regular hydraulic back-pulse cleanings during operation. AE assumes a periodic blowdown of the retentate, rejecting 10% of the influent flow (90% recovery), with a hydraulic cleaning time of two minutes per membrane train.

AE assumes that reject from membrane hydraulic cleans are sent to the sanitary sewer. However, there is opportunity to minimize waste residuals to be treated off-site through on-site reduction: recycle reject by sending supernatant to plant headworks or treat reject with a secondary membrane system. These options could be considered in future design phases, but are constrained by the limited footprint the site presents for on-site waste management.

Membrane Chemical Cleans and Service Life

In addition to hydraulic cleans, the membrane system will employ chemical cleans to reduce fouling. Maintenance cleans typically occur daily for each membrane train, taking an average of 30 minutes to complete. Every three to six months, a more extensive chemical cleaning, clean-in-place (CIP), using sodium hypochlorite and/or citric acid removes fouling from contaminants in membrane fibres and prolong the membrane service life. AE assumes that a membrane filtration skid would be offline for 6 to 12 hours for the CIP chemical cleaning.

CIP chemicals include acids and sodium hypochlorite; AE assumes that these solutions will be neutralized using caustic and calcium thiosulphate respectively. Once neutralized, the waste is delivered to the sanitary sewer.

Finished Water Turbidity

As an absolute barrier, membranes are expected to consistently achieve a reduction of turbidity down to 0.1 NTU or less and consistently achieve at least 3-log removal of *Giardia* and *Crypto* (Health Canada, 2019).

Membrane Filtration Package and Auxiliary Systems

The pre-packaged membrane treatment plant systems currently available are highly automated and are designed to require little day-to-day operator intervention. Automation includes timing and sequencing of back-pulsing and regular self-diagnostic tests for early detection of any membrane failures.

A complete membrane filtration system includes membranes, back-pulse pump, air compressor, blower, back-pulse supply tank, and system instrumentation, such as outlet turbidity meter and flow measurement. These are typically supplied as an equipment package from the membrane supplier.

A CIP tank, neutralization tank and skid along with individual chemical dosing skids are provided for chemical cleans.

4.2.6 Residuals Management

Process waste, general refuse, and service refuse (i.e. floor drains) must be properly managed, either on or off site. The process residuals generated from the WTP will include membrane hydraulic cleans and membrane chemical cleans. Wastewater generated from the WTP will include general refuse, floor drains, safety showers and eye wash waste, and lab wastes.

Under the conservative assumption of 90% recovery, 432 m^3 of waste is generated per day. AE assumes that the existing sanitary connections on nearby Cypress Road are sufficient to accommodate residuals. There is opportunity to reduce the quantity of waste delivered to the District's sanitary system by:

- Recycling hydraulic cleaning waste through a secondary membrane system; or
- Sending hydraulic cleaning waste to the head of the treatment plant.

AE recommends that the District pursue reduction of residuals in preliminary design.

5 COST ESTIMATE

The cost estimates presented herein are based on the limited information available on water quality of the two water sources and existing infrastructure. Major equipment suppliers were engaged for the conceptual design and preliminary equipment quotes.

The basis of the cost estimates for LSCA Wellfield and Mercantile Creek are described in Sections 4.1 and 4.2 respectively, noting that provisional items are not included in this estimate. The cost estimate for the new Highway Reservoir No. 2 is based on a 1400 m^3 bolted steel tank including foundation and instrumentation.

AE notes that the cost estimates provided may not be valid during detailed design due to the volatility of market fluctuation, particularly on Vancouver Island. The Class 'D' cost estimates provided should be re-examined at each phase due to changes in the construction market and material costs, as well as further refinement of the design.

The net present value life cycle cost is based on a 25-year project life cycle using a discount rate of 5% and an escalation rate of 2%. For the life cycle cost, the LSCA Wellfield upgrades are escalated for construction in 2024 and the Mercantile Creek upgrades are escalated for construction in 2022 as described in table 1-1 in Section 1.2.

Table 5-1
Class 'D' Capital Cost Estimates and Life Cycle Costs

Description	LSCA Wellfield Upgrades	Mercantile Creek Upgrades	Highway Reservoir No. 2
Capital Cost Estimate Total	$4,910,000	$4,020,000	$670,000
Annual O&M Costs	$272,000	$282,000	N/A
Life Cycle Cost (25-year)	$9,000,000	$8,900,000	N/A

A detailed breakdown of capital cost estimates is provided in Appendix A.

AE notes that the above Class 'D' cost estimate is in accordance with Engineers and Geoscientists of British Columbia's definition in the 2009 Budget Guidelines for Consulting Engineering Services (EGBC, 2009) which indicates the approximate magnitude of cost of the proposed project, based on the client's broad requirements, derived from lump sum or unit costs for a similar project. It may be used in developing long term capital plans and for preliminary discussion of proposed capital projects (EGBC, 2009).

6 CONCLUSIONS AND RECOMMENDATIONS

The concept design presented herein for the proposed treatment upgrades for the LSCA Wellfield and Mercantile Creek were developed based on existing water quality data and assumptions based on the existing system. The concept for the proposed Highway Reservoir No. 2 is based on the design of the existing Highway Reservoir No. 1. AE recommends the following improvements to the District's existing water supply infrastructure:

- Treatment upgrades to LSCA Wellfield to include hypochlorite addition to oxidize manganese followed by pressurized media filters for manganese removal. Existing treatment includes chlorination at the existing pump house. Treated water is delivered to the Highway Reservoir.
- Treatment upgrades to Mercantile Creek at the Bay Street WTP to include coagulant and soda ash addition prior to membrane filtration to remove organics and reduce turbidity. Existing treatment includes UV disinfection and chlorine disinfection with hypochlorite. Treated water is delivered to the Highway Reservoir
- Implementation of a new reservoir, Highway Reservoir No. 2 to provide additional treated water storage. Highway Reservoir No. 1 currently supplies water to Matterson Drive Reservoir (located in Ucluelet) that supplies treated water to the distribution system.

AE prepared a Class 'D' capital cost estimate for the proposed works of LSCA Wellfield upgrades, Mercantile Creek treatment upgrades (at the Bay Street WTP), and Highway Reservoir No. 2. The total capital cost estimate is $9,600,000 for the proposed infrastructure upgrades.

AE recommends further development in preliminary and detailed design stages to confirm the following for the proposed upgrades:

- Bench-scale and pilot-scale testing for Mercantile Creek to verify:
  - Effective chemical pre-treatment dose and hydraulic retention time;
  - Pre-treatment methods: flocculation and settling or dissolved air floatation; and
  - Filtration methods: refine membrane filtration parameters.
- Assessment of hydraulic profile to determine whether booster pumps are required to assist in delivery from treatment plants to Highway Reservoir No. 1.
- Assessment of wells in LSCA:
  - GARP hazard screening and assessment to determine if additional filtration and disinfection is required; and
  - Bench-scale and pilot-scale testing to determine oxidant dose and contact time.

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CERTIFICATION PAGE

This report presents our findings regarding the District of Ucluelet, Feasibility Study of Water Treatment Upgrades for Mercantile Creek and Lost Shoe Creek Wellfield.

Prepared by:

Rachel Trower, EIT
Water Process Engineer

PROFESSIONAL
PROVINCE OF
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BRITISH COLUMBIA
ENGINEER

Quinn Crosina, M.A.Sc., P.Eng.
Manager - Water

Reviewed by:

Keith Kohut, M.A.Sc., P.Eng.
Senior Review Engineer

RT/QC/KK/lp

APPENDIX A - COST ESTIMATE

Investing in Canada Infrastructure Program

Green Infrastructure - Environmental Quality

Detailed Cost Estimate

Applicant Name: District of Ucluelet
Project Number:
Project Title: Ucluelet Water Treatment Upgrades - LSCA Wellfield
Project Category:
Cost Estimate Developed By: Quinn Crosina
Date of Cost Estimate (DD-MM-YYYY): 26-02-2020
Cost Estimate Class (A,B,C,D): Class D (+/- 50%)

ELIGIBLE COSTS

	Description	Quantity	Per Unit Amount	Total Cost
Project Planning				
For example, costs associated with environmental assessment, aboriginal consultation, climate lens assessments, community employment benefit plans	Administration costs	1.00	80,000.00	80,000
	Miscellaneous planning & investigations	1.00	54,000.00	54,000
				0
				0
	Planning Sub-Total:			**$134,000**
Design / Engineering				
(Note max 15% of construction project costs should be engineering/consulting fees)	Engineering Services (Design)	1.00	399,000.00	399,000
				0
	Design / Engineering Sub-Total:			**$399,000**
Construction / Materials				
Items should reflect the major components in your project without going into specific detail, add lines as necessary	Construction Mobilization / Demobilization	1	240,000	240,000
	Site preparation & Civil Works	1	172,000	172,000
	Process Mechanical Equipment & Installation	1	1,030,000	1,030,000
	Structural Materials & Installation	1	500,000	500,000
	Building Mechanical Equipment & Installation	1	81,000	81,000
	Electrical, Instrumentation & Controls Equip & Install.	1	285,000	285,000
	Contractor Overhead & Profit (15% of Equipment & Install)	1	347,000	347,000
	Escalation (assumes 4% per year for 1 year)	1	128,000	128,000
	Construction / Materials Sub-Total:			**$2,783,000**
Other Eligible Costs				
For example (communications, testing)				0
				0
	Other Eligible Costs Sub-Total:			**$0**
Contingency				
	Design & Construction Contingency (50%)	1.00	1,594,000.00	1,594,000
	Contingency Sub-Total:			**$1,594,000**
	TOTAL ELIGIBLE COSTS*:			**$4,910,000**

INELIGIBLE COSTS

	Description	Quantity	Per Unit Amount	Total Cost
Land Acquisition Cost				
Leasing Land, Building and Other Facilities				
Financing Charges				
Legal Fees				
In-kind Contribution				
Tax Rebate				
Other				
	TOTAL INELIGIBLE COSTS*:			**$0**

TOTAL GROSS PROJECT COSTS (Eligible + Ineligible)*:	**$4,910,000**

*Totals must match totals in the Project Costs section of the Application Form.

Cost Estimate Comments

Please add any information that you feel is relevant to your cost estimate

Canada

Investing in Canada Infrastructure Program

BRITISH COLUMBIA

Green Infrastructure - Environmental Quality

Detailed Cost Estimate

Applicant Name: District of Ucluelet
Project Number:
Project Title: Ucluelet Water Treatment Upgrades - Bay St WTP
Project Category:
Cost Estimate Developed By: Quinn Crosina
Date of Cost Estimate (DD-MM-YYYY): 26-02-2020
Cost Estimate Class (A,B,C,D): Class D (+/- 50%)

ELIGIBLE COSTS

	Description	Quantity	Per Unit Amount	Total Cost
Project Planning				
For example, costs associated with environmental assessment, aboriginal consultation, climate lens assessments, community employment benefit plans	Administration costs	1.00	64,000	64,000
	Miscellaneous planning & investigations	1.00	43,000	43,000
				0
				0
Planning Sub-Total:				**$107,000**
Design / Engineering				
(Note max 15% of construction project costs should be engineering/consulting fees)	Engineering Services (Design)	1.00	318,000	318,000
				0
Design / Engineering Sub-Total:				**$318,000**
Construction / Materials				
Items should reflect the major components in your project without going into specific detail, add lines as necessary	Construction Mobilization / Demobilization	1	87,000	87,000
	Site preparation & Civil Works	1	65,000	65,000
	Process Mechanical Equipment & Installation	1	963,000	963,000
	Structural Materials & Installation	1	552,000	552,000
	Building Mechanical Equipment & Installation	1	21,000	21,000
	Electrical, Instrumentation & Controls Equip & Install.	1	150,000	150,000
	Contractor Overhead & Profit (15% of Equipment & Install)	1	277,000	277,000
	Escalation (assumes 4% per year for 2 years)	1	208,000	208,000
				0
Construction / Materials Sub-Total:				**$2,323,000**
Other Eligible Costs				
For example (communications, testing)				0
				0
Other Eligible Costs Sub-Total:				**$0**
Contingency				
	Design & Construction Contingency (50%)	1.00	1,272,000.00	1,272,000
Contingency Sub-Total:				**$1,272,000**
TOTAL ELIGIBLE COSTS*:				**$4,020,000**

INELIGIBLE COSTS

	Description	Quantity	Per Unit Amount	Total Cost
Land Acquisition Cost				
Leasing Land, Building and Other Facilities				
Financing Charges				
Legal Fees				
In-kind Contribution				
Tax Rebate				
Other				
TOTAL INELIGIBLE COSTS*:				**$0**

TOTAL GROSS PROJECT COSTS (Eligible + Ineligible)*:	**$4,020,000**

*Totals must match totals in the Project Costs section of the Application Form.

Cost Estimate Comments

Please add any information that you feel is relevant to your cost estimate

Canada

Investing in Canada Infrastructure Program

BRITISH COLUMBIA

Green Infrastructure - Environmental Quality

Detailed Cost Estimate

Applicant Name: District of Ucluelet
Project Number:
Project Title: Ucluelet Water Treatment Upgrades - Hwy Reservoir
Project Category:
Cost Estimate Developed By: Quinn Crosina
Date of Cost Estimate (DD-MM-YYYY): 26-02-2020
Cost Estimate Class (A,B,C,D): Class D (+/- 50%)

ELIGIBLE COSTS

	Description	Quantity	Per Unit Amount	Total Cost
Project Planning				
For example, costs associated with environmental assessment, aboriginal consultation, climate lens assessments, community employment benefit plans	Administration costs	1.00	11,000	11,000
	Miscellaneous planning & investigations	1.00	7,000	7,000
	Planning Sub-Total:			**$18,000**
Design / Engineering				
(Note max 15% of construction project costs should be engineering/consulting fees)	Engineering Services (Design) (10%)	1.00	35,000	35,000
	Design / Engineering Sub-Total:			**$35,000**
Construction / Materials				
Items should reflect the major components in your project without going into specific detail, add lines as necessary	Bolted Steel Tank c/w site prep, foundation & install	1	303,000	303,000
	Contractor Overhead & Profit (15% of Equipment & Install)	1	46,000	46,000
	Escalation (assumes 4%/year for 4 years)	1	68,000	68,000
	Construction / Materials Sub-Total:			**$417,000**
Other Eligible Costs				
For example (communications, testing)				
	Other Eligible Costs Sub-Total:			**$0**
Contingency				
	Design & Construction Contingency (50%)	1.00	200,000	200,000
	Contingency Sub-Total:			**$200,000**
	TOTAL ELIGIBLE COSTS*:			**$670,000**

INELIGIBLE COSTS

	Description	Quantity	Per Unit Amount	Total Cost
Land Acquisition Cost				
Leasing Land, Building and Other Facilities				
Financing Charges				
Legal Fees				
In-kind Contribution				
Tax Rebate				
Other				
	TOTAL INELIGIBLE COSTS*:			**$0**

TOTAL GROSS PROJECT COSTS (Eligible + Ineligible)*:	**$670,000**

*Totals must match totals in the Project Costs section of the Application Form.

Cost Estimate Comments

Please add any information that you feel is relevant to your cost estimate